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Corrosion Engineers and Nuclear Waste Disposition

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Corrosion Engineers and Nuclear Waste Disposition

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More and more articles appear in the press daily about the renaissance of nuclear energy. Even many former opponents of nuclear energy are now convinced that nuclear energy is more environmentally friendly than burning fossil fuels. Nuclear energy does not release carbon dioxide to the atmosphere and therefore does not contribute to the global warming problem. But nuclear energy produces spent fuel or nuclear waste. Spent fuel is radioactive and requires thousands of years of isolation from plants, animals and humans.

Every country currently studying the option for disposing of high-level nuclear waste has selected deep geologic formations to be the primary barrier for accomplishing this isolation. It is postulated that by the very nature of these geological sites, they will contain the waste for long time, limiting the spread of radionuclides, for example, through water flow. The release of radionuclides to the environment can also be delayed by the construction of engineered barrier systems between the waste and the geologic formation. Corrosion engineers are participating in the design and the performance prediction of the engineered barriers. The principal engineered component in this multibarrier approach is the container for the waste. Beyond the metallic containers, other engineered barriers could be added to attenuate the impact of the emplacement environment on the containers. The containers will probably be concentric double walled vessels of dissimilar metals. Each vessel would have a specific function. For example, the inner container may be designed to shield radiation and provide structural support to facilitate the safe handling and emplacement operations. This inner container may be over-packed with a

corrosion-resistant outer layer. The design of the different containers for nuclear waste would vary according to the nature of the geologic formation at the site of the repository.

The most common host rocks for nuclear waste repositories in the world are clay, basalt, tuff and granite. The groundwater associated with the containers should all be relatively benign to most materials because of their low ionic strengths, near neutral pH, and low concentrations of halide ions. The corrosiveness of these waters could increase if significant vaporization occurs due to heating from radioactive decay during the early times of emplacement. Many different alloys are currently being studied for the container materials, including carbon steel, stainless steel, titanium, copper, and nickel alloys.

Twenty years ago, most of the designs for repositories specified life spans of 300 to 1000 years. Today, some designs are considering lifetimes as high as 1,000,000 years. This requirement has created a difficult problem for engineers to solve. The unique aspect of this problem is associated with making predictions about the corrosion behavior of container materials for extended periods of time. Many of the alloy systems being considered have been in existence for less than 100 years. The understanding and methodologies of existing corrosion engineering remain largely oriented to traditional problems involving less corrosion resistant alloys and corrosion behavior over time periods less than decades. Predicting the behavior of engineering alloys over geologic time periods poses new challenges but at the same time offers new opportunities for the development of corrosion science.

Even though nuclear energy has been in use for half a century, no country currently operates a nuclear waste repository. The current renaissance of public interest in nuclear energy may put some pressure on the development of the repositories. Building a nuclear waste repository is a long process since the whole society needs to be ready for it, and nowadays this society may extend beyond country lines. Corrosion engineers can help.

R. B. Rebak, 31 July 2006

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